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A request for correction of the description has been filed pursuant to Rule 88 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 3.).

(54) Device for unwinding stretchable plastic film

(57) The invention relates to an unwinding unit for extendable plastic film (P), in particular in a pallet-wrapping machine, comprising at least one pair of motorized unwinding and pre-stretching rollers (6,7) and at least one guide roller (10) mounted on at least one substantially rigid support arm (13) associated with means (17) for sensing the force applied onto the guide roller (10) by the tension of the film being unwound. According to the invention, said support arm (13) extends, beyond its pivoting axis, parallel to the axis of the respective guide roller, in the form of a pressure lever (16), the free end of which rests, in a "floating" manner, on the load sensor (17). Preferably, said support arm is mounted aligned in the plane lying between its pivoting axis and the axis of rotation of the unwinding unit. Moreover, an additional guide roller (11) is provided downstream of the guide roller mounted on said support arm (13), having the function of an exit roller (11) for the film from the unwinding unit.

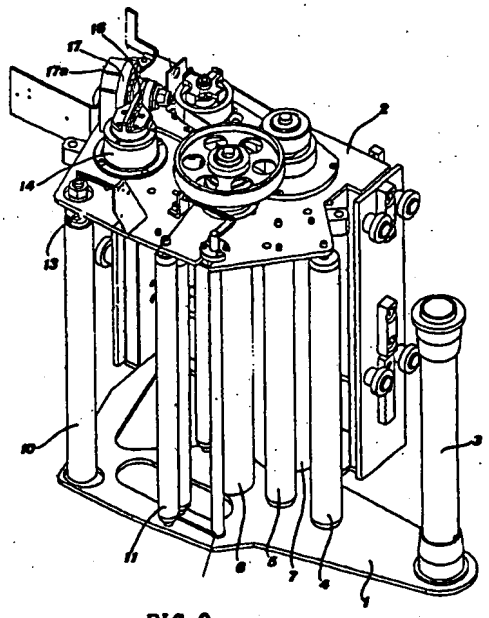

FIG.3

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Description

[0001] The present invention relates to an unwinding unit for plastic film in pallet-wrapping machines. In particular, it relates to the means for controlling the tensioning of the film.

[0002] In the packaging or stabilization of palletized products, i.e. products loaded onto pallets, or in the production of multiple packages of products of various kinds (for example bags filled with coffee) grouped together in bundles, use is widely made of pallet-wrapping machines in which a film of extendable plastic (for example low-density linear polyethylene) is wound around the batch of products. This type of extendable film is characterized by a notable capacity of extension and of keeping its elasticity, so as to be able to exert a tightening and retaining action on the products around which it is wound.

[0003] In commerce there exists various types of pallet-wrapping machines, which may be essentially classified as two types: a first type, in which the load to be packaged is fixed, while the unit for unwinding the extendable film rotates around it and moves vertically with respect thereto, spirally winding the film; and a second type, in which the unwinding unit is simply displaceable vertically and the load is kept rotating about its axis, in front of the unwinding unit. The two embodiments therefore have in common the capacity to perform a relative vertical translation and rotational movement, between the unwinding unit and the load to be wrapped, as a result of which the film is distributed over the load in spiral form.

[0004] For some time now, films consisting of highly extendable material, which allow a more or less constant pulling tension to be maintained with an elongation variable from about 80% to about 300%, have been widely used: therefore it is preferred to lengthen the film before winding it around the product, not only in order to confer on it the desired technical retaining characteristics, but also so as to use less material for the same results. This lengthening operation - also called "pre-stretching" - is generally performed at the same time as unwinding of the film, by causing the latter to pass between a pair of rubberized rollers positioned close to each other, i.e. so-called pre-stretching rollers; these rollers operate at different speeds, the downstream roller having a peripheral speed greater than that of the upstream roller.

[0005] The unwinding unit, together with the associated pre-stretching rollers, has assumed over time different forms and characteristics with the aim of improving more and more its performance and overcoming the problems associated with operation thereof.

[0006] In fact, this unwinding unit must not simply release the film, causing it to unwind from the reel, after lengthening it, but must be able to keep its operating parameters - and in particular the tension imparted to the film - as far as possible constant, despite the fact that the winding conditions are variable with a certain periodic frequency. In fact, since the load to be wrapped does not necessarily have a circular, but, for example, a generally rectangular or square cross-section, the peripheral winding speed of the film $V = \Omega * R$ (where Ω is the relative angular speed between the supply head and the load to be wrapped and R is the distance between the centre of rotation and the perimeter of the load) will vary depending on the irregularities of the load.

[0007] For the wrapping to occur correctly, it is therefore essential that the film, once lengthened after passing through the pre-stretching rollers, be kept at a predetermined tension until it is applied to the load. This is of fundamental importance both for soft loads (for example, boxes containing fragile or low-consistency material), for which the tension applied on the load must be kept as low as possible (for example between 1.5 kg and 2 kg), and for stable and heavy loads, for which it is preferable to apply a high tension, which is close to the breaking point of the film.

[0008] If the supply speed of the film were to be kept constant, the irregularities in the winding speed would affect the tension applied to the film, creating a pulsating effect, resulting in non-uniform an inefficient application of the film onto the load. Therefore, it is necessary to regulate the supply speed so as to adapt it in an instantaneous manner to the requirements.

[0009] A first solution offered in the known art is that disclosed by Italian patent No. 1,179,310 dated 10.4.1984 in the name of ROBOPAC. In this patent, an idle roller - also called a "dandy" roller - is used, being located downstream of the pre-stretching rollers and mounted at the end of an oscillating arm: the film, passing over the dandy roller, applies to the end of the oscillating arm a pressure - greater or less depending on the instantaneous requirements of the film - which causes the arm to oscillate against a suitably calibrated damping element. Oscillation of the arm acts on a position transducer, which emits a signal controlling the speed of rotation of a motor actuating the unwinding unit, varying the supply speed correspondingly.

[0010] A second solution proposed by the prior art consists in mounting the idle guide roller at the end of a rigid fixed arm and associating said idle roller with a speedometer dynamo. Passing of film over the idle roller causes rotation of the latter, and therefore of the dynamo, which produces an electric current with an intensity proportional to the speed of rotation; this current signal, suitably processed, provides the desired control signal for the electric motor actuating the pre-stretching unit.

[0011] These known devices, however, have a series of drawbacks and limitations which are clearly highlighted in the description of Italian patent No. 1,293,829 filed on 7.8.1997 in the name of the same Applicant. Consequently, in this same patent, as well as in the preceding Italian patent No. 1,278,195 filed on 10.5.1995 in the name of ROBOPAC, it is likewise proposed mounting said idle guide roller on one or more substantially rigid

arms, integral with the frame of the pre-stretching unit and also fitting a strain gauge to these arms; each of these strain gauges is therefore able to emit a signal proportional to the degree of flexing of the respective arm under the load produced by the tension of the film. These signals are then used in order to regulate the motor supplying the said film.

[0012] The devices described in these patents, although they have resulted in a substantial improvement compared to the prior art, are, however, in turn not devoid of drawbacks associated basically with the fact that the measuring strain gauges used as tension sensors are subject:

[0013] on the one hand, to a "constant static shear stress" due to the intrinsic weight of the idle guide roller. In other words, flexing of the support arm occurs not only in the horizontal plane, as a result of the greater or less pulling force on the film (which is that which must be measured), but also in the vertical plane, precisely because of the weight of the idle guide roller. Therefore, the strain gauge sensor provides a first spurious signal, which does not depend on the tension of the film;

[0014] on the other hand, to a "variable dynamic shear stress" during winding, due to the upward and downward movement of the unwinding unit. In other words, as a result of the upward and downward movement of the unwinding unit - which is necessary in order to distribute the film over the entire height of the load - the effect of the film tension also results in a pulling component in the vertical direction, the degree and direction of which are variable and which produces non-controllable spurious signals which are added to the spurious signal referred to above.

[0015] The main object of the present invention is therefore to provide a device for controlling the tensioning of the extendable film, which fully overcomes the abovementioned drawbacks and which, in particular, eliminates the production of spurious signals due to unwanted stresses affecting the strain gauge sensor.

[0016] Such an object is achieved with a device as claimed in Claim 1. In this way, only pressure forces which are produced in the horizontal plane are transmitted to the strain gauge sensor; the flexing forces which are produced in the vertical plane are, instead, absorbed by the pivoting axis of the support arm and by the associated pressure lever.

[0017] The devices described in the two abovementioned patents Nos. 1,278,195 and 1,293,829 are, however, also subject to another drawback - which occurs in fact only in the case of pre-stretching units rotating about the load, i.e. in the case of rotating-arm machines - consisting in the fact that the strain gauge sensor is also subject to an "additional flexing stress" produced by the centrifugal force which is applied to the idle guide roller due to the rotation of the entire unwinding unit. Here also, the effect of this stress is to introduce in turn spurious signals, which are added to the ones mentioned above.

[0018] A further object of the present invention is therefore to provide an unwinding unit which also overcomes this drawback; this object is achieved by means of the characteristic features which are described in Claim 2. In this way, in fact, the thrust produced by the centrifugal force on the idle guide roller is directly absorbed by the pivoting axis of the associated support arm, namely does not produce any rotational component about said pivoting axis.

[0019] Finally, yet another drawback of the devices described in the two abovementioned patent Nos. 1,278,195 and 1,293,829 consists in the fact that the strain gauge sensor is also subject to a "stress variable with the variation in the winding angle", which causes a signal variable in an uncontrolled manner. This winding angle - which is formed by the alignment of the film between the edge where it leaves the idle guide roller and the edge where it enters the load to be wound - obviously varies depending on the variations in the radius of the load; and this radius varies not only depending on the shapes of the different loads to be wrapped, but also depending on the variations in shape of a same load with respect to a theoretical cylindrical shape.

[0020] Therefore, yet another object of the present invention is to provide an unwinding unit with a tension controlling device which also overcomes this drawback; this object is achieved by means of the characteristic features which are described in Claim 3. In this way, pulling of the film occurs at an angle variable with respect to said additional exit roller and therefore does not have any effect on the guide roller associated with the strain gauge sensor.

[0021] Further characteristic features and advantages of the device according to the invention will emerge in any case more clearly from the detailed description which follows of a preferred embodiment thereof, provided by way of example and illustrated in the accompanying drawings, in which:

[0022] Fig. 1 is a schematic plan view of an unwinding unit according to the invention;

[0023] Fig. 2 is also a plan view of a functional diagram of the unwinding unit according to Fig. 1;

[0024] Fig. 3 is an overall, schematic, perspective view of the unwinding unit according to Fig. 1; and

[0025] Fig. 4 is a schematic vertical section along the line IV-IV in Fig. 1.

[0026] Here and below reference is made, by way of example, to a pallet-wrapping apparatus of the rotating-arm type, but it is understood that the device according to the invention may be advantageously applied also to pallet-wrapping apparatus with a rotating load.

[0027] As can be clearly seen from Figs. 1 to 3, the rotating unwinding unit comprises a plurality of rollers for guiding and driving the film P, which are mounted on a frame formed essentially by two support plates 1 and 2. More precisely, the following are envisaged: a roller 3 intended to support the reel B supplying the film P, a first pair of idle guide rollers 4 and 5, a pair of pre-stretch-

ing rollers 6 and 7, the roller 7 of which is motorized and the roller 6 driven (as described more fully below), an additional pair of guide rollers 8 and 9, a sensor guide roller 10 associated with film tension sensor means, and an exit guide roller 11, from where the film P is conveyed away towards the load being wound (not shown) in the direction D.

[0028] The film P is unwound from the reel B along the path indicated by the dot-dash line in Fig. 2, through the series of rollers 4, 5, 6 and 7. As can be seen, when passing over the pre-stretching rollers 6 and 7, the film is wound over an arc preferably greater than 180° such as to ensure stable adhesion of the film to the surface of the rollers; this ensures that, along the path between the roller 6 and the roller 7 - which rollers are actuated by the motor M so that the downstream roller 7 is moved at a peripheral speed greater than that of the upstream roller 6 - the film may undergo the desired stretching action. The degree of said stretching is determined by the ratio between the peripheral speeds of the rollers 6 and 7 and may be, as is known, as much as 300%.

[0029] The film thus pre-stretched then proceeds from the roller 7 towards the rollers 8, 9, 10 and 11 and from the latter is fed in the direction D towards the load on the pallet to be wound.

[0030] According to the fundamental characteristic feature of the invention, and as can be clearly seen from Fig. 4, the sensor guide roller 10 is mounted idle on a shaft 12, which is fixed to the support arm 13 at its top end only. The arm 13 is integral with a hub 13a which is mounted inside a bush 14 by means of a pair of radial bearings 15. The bush 14 is mounted fixed on the plate 2 of the unwinding unit.

[0031] A pressure lever 16 is fixed to the top end of the hub 13a by means of position adjusting means which are known per se and therefore not illustrated in greater detail. The free end of said lever rests on a strain gauge sensor 17 which is supported in a fixed position by a rigid support 17a which is also integral with the plate 2. The free bearing of the end of the pressure lever 16 on the strain gauge sensor is obtained in a "floating" manner, this term being understood as meaning that the supporting action is essentially free in the vertical plane of the surface of the strain gauge sensor, such that the forces which are exerted in a direction perpendicular to this plane, and therefore solely pressure forces, may be transmitted to said sensor.

[0032] As already mentioned initially, the forces transmitted to the assembly consisting of the sensor guide roller 10 and shaft 12, by the tension of the film being unwound, tend to cause flexing movements of the arm 13 which have components both in the vertical plane and in the horizontal plane, as well as possible torsional movements due to cantilever-type mounting of the shaft 12 on the end of the arm 13. However, by means of the constructional form described above, the flexing movements in the vertical plane, as well as any torsional movements, are absorbed by bearings 15 and therefore by the fixed bush 14; while the flexing movements in the horizontal plane - and solely said movements - are transferred to the pressure lever 16 and from the latter are applied as pressure forces alone to the strain gauge sensor 17.

[0033] The electric signal generated by the strain gauge sensor 17 is suitably processed, using techniques known in the sector of strain gauges, so as to provide the desired signal for regulating the motor M actuating the pre-stretching rollers 6 and 7.

[0034] It is important to note that the support arm 13 and the associated pressure lever 16 are substantially fixed, whereby it must be considered that the pressure produced by the lever 16 on the strain gauge sensor 17 basically results from an infinitesimal rotational movement of the arm 13 due to the effect of the tension applied to the sensor guide roller 10. Any problem of inertia in the movement of the arm 13, such as that present in the "dandy roller" arrangement according to the above-mentioned Italian patent No. 1,179,310, is therefore excluded.

[0035] According to a further advantageous arrangement of the present invention, the arm 13 is oriented with an alignment coinciding with the vertical plane (schematically indicated by the dot-dash line X-X partly overlapping the cross-sectional line IV-IV) lying between the vertical pivoting axis of the hub 13a of the said arm 13 and the axis of rotation (not shown) of the unwinding unit around the load to be wrapped. Owing to this arrangement, the centrifugal force which acts on the sensor guide roller 10 and shaft 12 - upon rotation of the unwinding unit along the path T - is converted into a thrust which in turn is completely absorbed by the fixed bush 14. In other words, the centrifugal force is thus not able to produce any rotational component of the arm 13 which could possibly result into a pressure on the strain gauge sensor 17.

[0036] Finally, in accordance with a further advantageous arrangement of the unwinding unit according to the invention, the sensor guide roller 10 does not perform also the function of an exit roller for conveying the film P towards the load, as occurs in all the arrangements of the known art. An additional roller 11, downstream of the roller 10, is in fact envisaged, said roller 11 having just the function of an exit roller. Owing to the presence of this exit roller 11, the tension of the section of the film P which passes - with a variable angle, as described above - between the exit roller 11 and the load being wound transmits its variable effect solely onto the roller 11, without any variability effect occurring on the sensor guide roller 10.

[0037] It is understood, however, that the invention is not limited to the particular configurations described above, which form solely non-limiting examples of the scope of the invention, but that numerous variations are possible, all within the grasp of a person skilled in the art, without thereby departing from the scope of the invention, as defined by the claims which follow.

Claims

1. Unwinding unit for extendable plastic film (P), in particular in a pallet-wrapping machine, comprising at least one pair of motorized unwinding rollers (6, 7) and at least one sensor guide roller (10) mounted on at least one substantially rigid support arm (13) associated with means (17) for sensing the force applied onto the sensor guide roller (10) by the tension of the film being unwound, **characterized in that** said support arm (13) is mounted on its own pivoting axis, beyond which it extends in the form of a pressure lever (16), the free end of the latter resting, in a "floating" manner, on said sensor means (17).

2. Unwinding unit according to Claim 1, **characterized in that** said sensor means consist of a strain gauge sensor.

3. Unwinding unit according to Claim 1, **characterized in that** said support arm is mounted aligned in the plane lying between its pivoting axis and the axis of rotation of the unwinding unit.

4. Unwinding unit according to Claim 1, **characterized in that** it comprises an additional guide roller (11) having the function of an exit roller for the film from the unwinding unit, this exit roller (11) being arranged downstream of the sensor guide roller (10) mounted on said support arm.

5. Unwinding unit according to any one of the preceding claims, **characterized in that** said pair of motorized unwinding rollers (6, 7) comprises means for pre-stretching the plastic film.

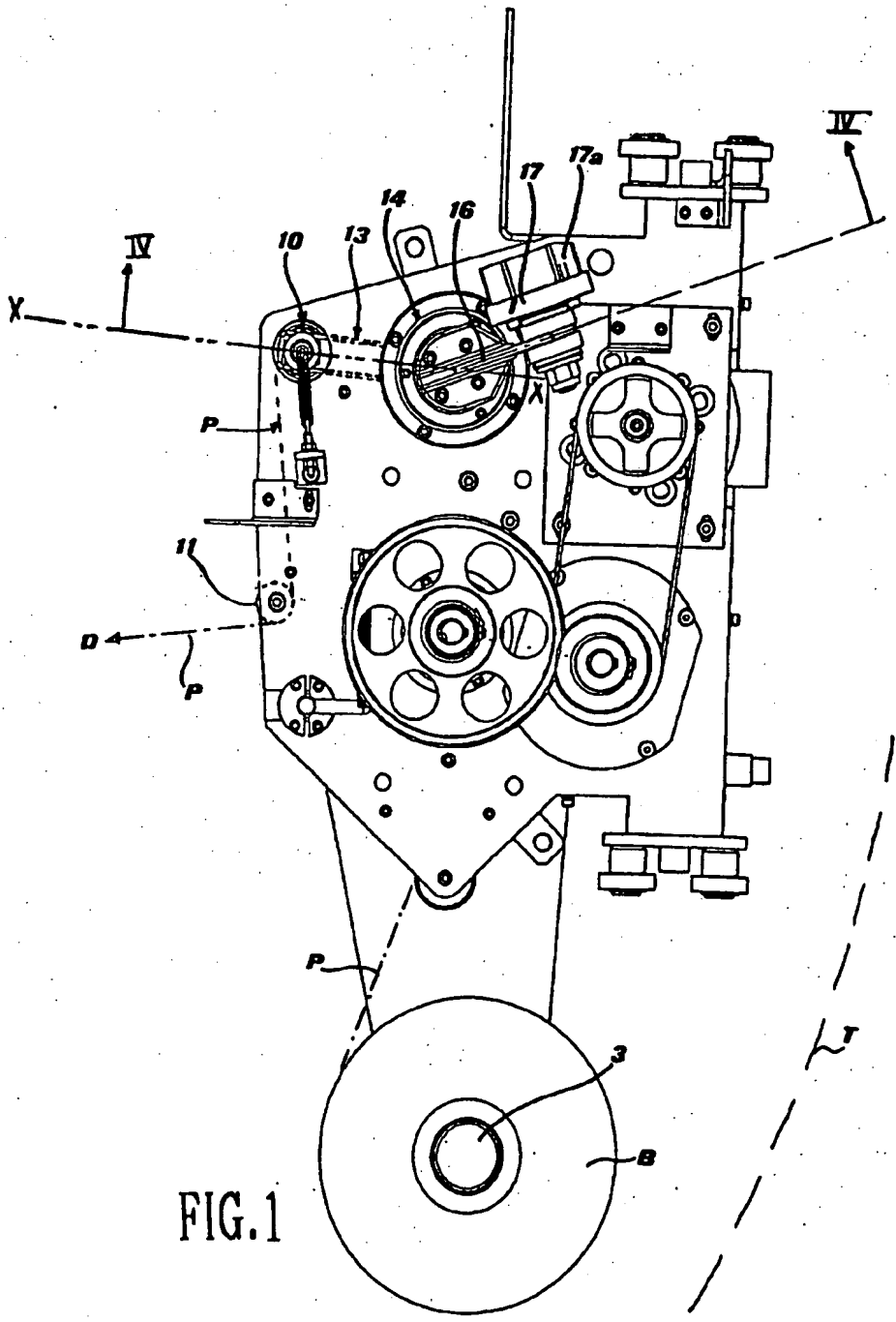

FIG.1

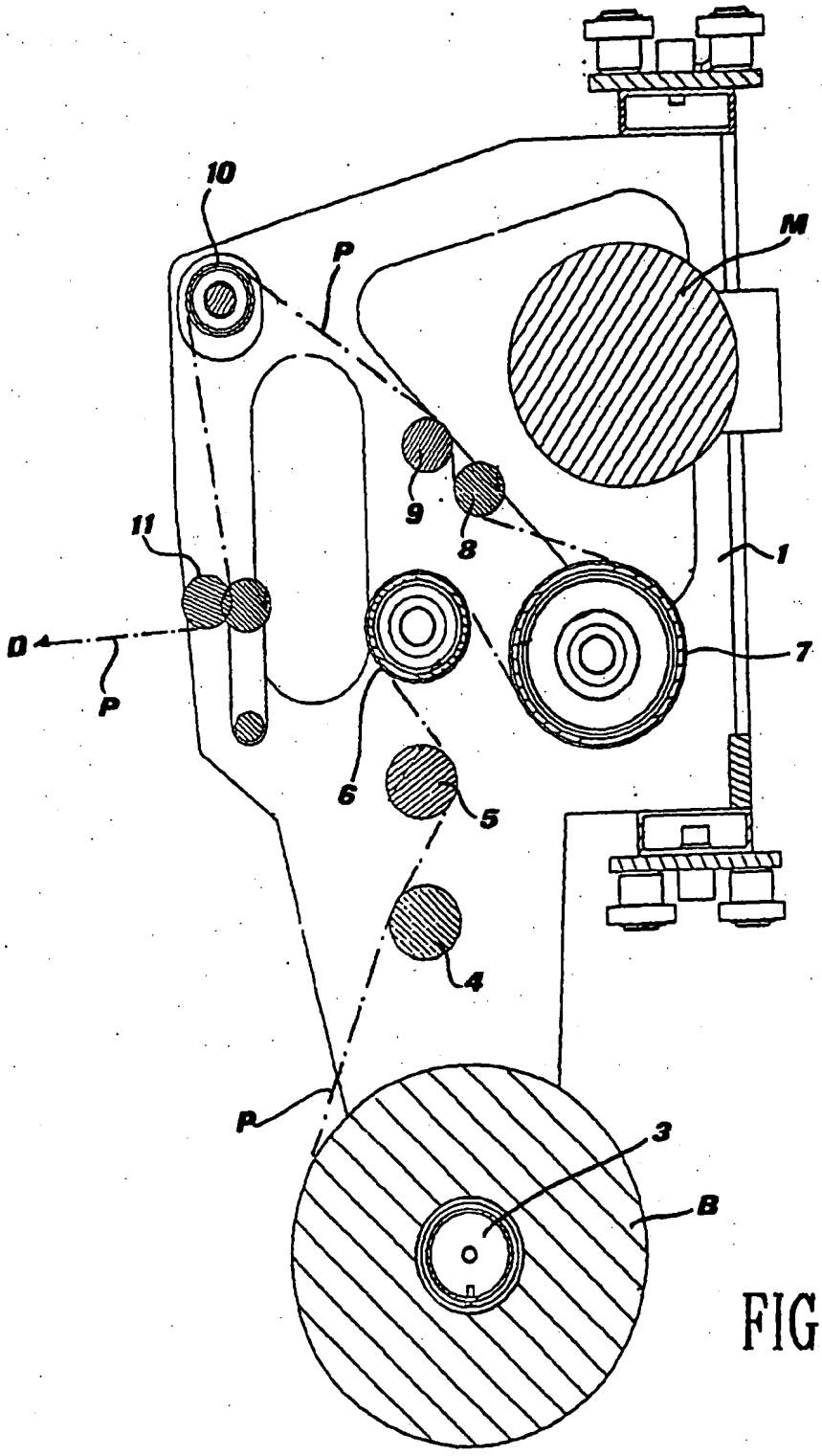

FIG.2

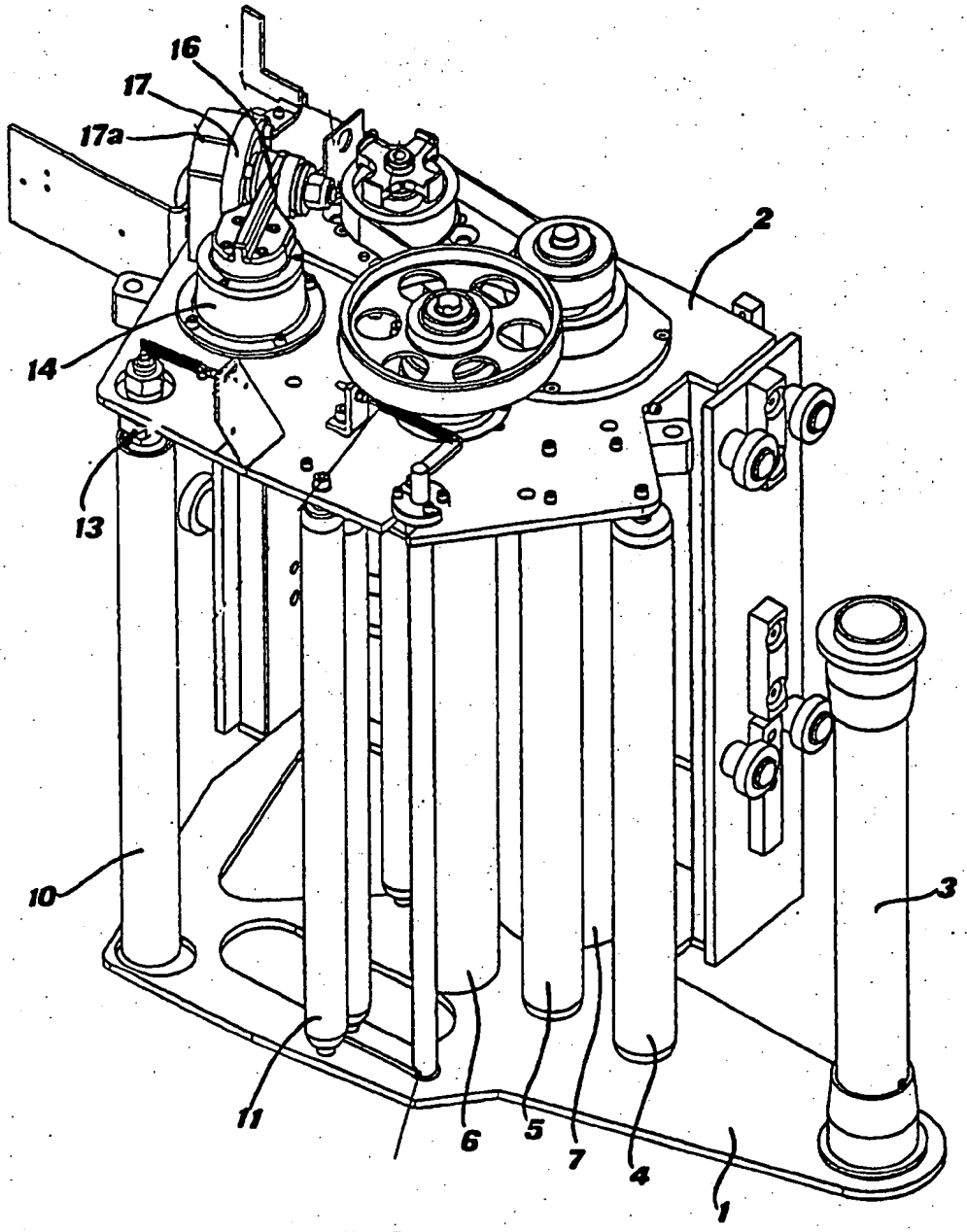

FIG.3

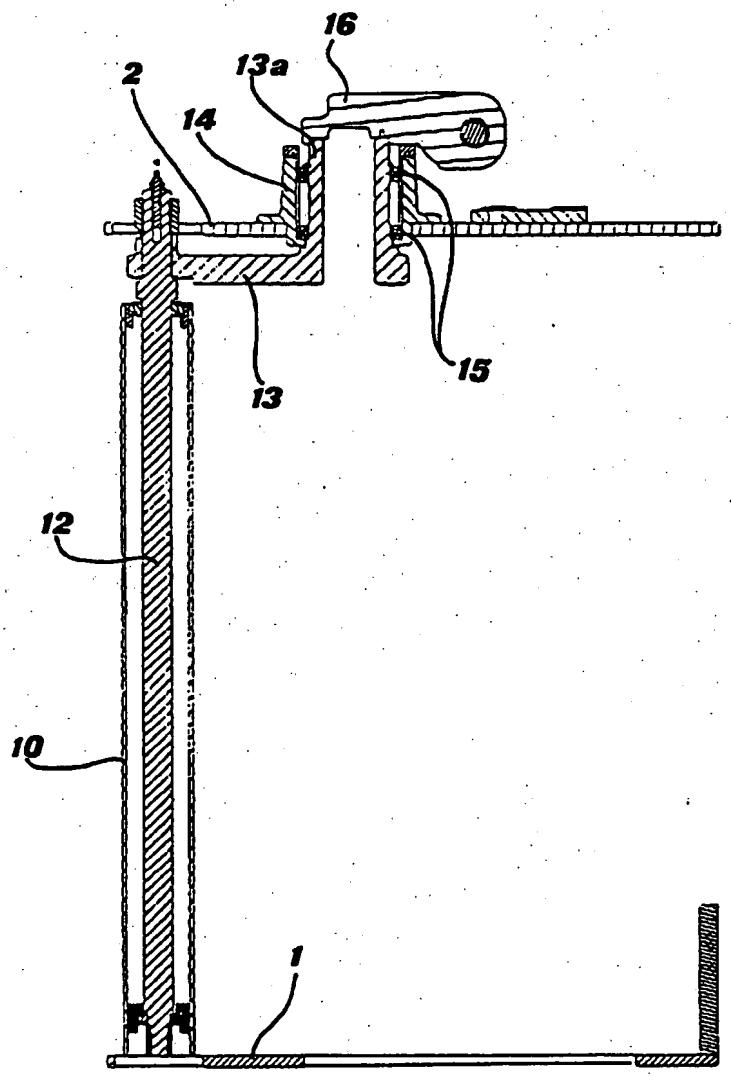

FIG.4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 10 3118

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 February 2002	Jagusiak, A

CATEGORY OF CITED DOCUMENTS

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